

Mitigation of Arctic warming by controlling European black carbon emissions (MACEB): modelling results



Joni-Pekka Pietikäinen¹, K. Kupiainen^{2,3}, A.-P. Hyvärinen¹, Z. Klimont³, R. Makkonen⁴, R. Karinkanta¹, D. O'Donnell¹, A. Laaksonen¹, H. Lihavainen¹ and V.-M. Kerminen⁴

¹Finnish Meteorological Institute, ²Finnish Environment Institute SYKE, ³International Institute for Applied Systems Analysis, ⁴Department of Physics, University of Helsinki

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AMAP Report (No. 4, 2011): The Impact of Black Carbon on Arctic Climate



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MACEB project



- study approaches to mitigate warming of Arctic climate by black carbon (BC) emissions reduction at mid latitudes, especially at Europe
 - identify knowledge gaps and uncertainties in how BC emissions can be linked with radiative forcing in Arctic areas
- assess the impact of the current air quality and climate relevant legislation in the northern hemisphere on BC emissions, their transport to the Arctic, and eventually Arctic warming and how it relates to warming by CO₂
- to transfer action procedures and experiences to various stakeholders (modelling community, national authorities) within EU by implementing a web portal to assess and mitigate BC emissions from most important source sectors, especially small-scale wood burning



Tools of the project



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models

- GAINS (IIASA)
 - main tool for providing the emission data
- ECHAM5-HAM2
 - global aerosol-climate model
- REMO-HAM
 - regional aerosol-climate model
- measurements
 - BC concentrations
 - snow albedo
 - BC in snow

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Simulations



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- simulated time period 5 years
 - averaged to one year
 - internal variability
- 2005 base year
- scenarios for 2020 and 2030
- additional 2005: No-Eu27, No-Fin, ...
- nudged simulation
 - 2003-2007 ERA-Interim
 - understanding the Arctic climate in current climate conditions
- new/updated emissions



New/updated emissions



- \blacktriangleright QUANTIFY aviation: 2000 \rightarrow 2005, 2020 & 2030
- ► GFED 3.1 wildfire (Giglio et al., 2010, van der Werf et al., 2010)
 - vertically AEROCOM approach
 - 6 different sectors, only 5 used (AWB removed)
- Ship emissions
 - Global proxy (Wang et al., 2008)
 - Arctic emissions (Corbett et al., 2010)
 - overlapping emissions from Arctic database
- GAINS
 - \blacktriangleright 6 sectors for BC/OC and 7 sectors for SO_2
 - TRACE-P method applied for domestic sector
- for emission sizes AEROCOM approach used



Emission scenarios



- 2020 and 2030: CLEC and CLECC scenarios include all presently agreed policies affecting air pollutant emissions, but CLECC is further designed to keep the total forcing due to long-lived greenhouse gases at 450ppm CO₂-equivalent level by the end of the century via CO₂ mitigation measures mostly targeting the energy production and industrial sectors
- 2030: BCadd scenario includes a portfolio of most important measures that could yield the largest reductions in radiative forcing from short-lived climate forcers (SLCFs) at the global scale
- 2030: MTFR implements the maximum reduction potential of aerosol and SO₂ emissions with currently available technologies



like :

Measured and modelled surface air BC values from 2007





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Black carbon changes compared to the base run (2005): Arctic Circle

Simulation	∆burden [%]	Δ surf. air [%]	Δ flux snow&ice [%]
No-Eu27	-4.9	-14.6	-16.1
No-Fin	-0.3	-2.7	-1.9
CLEC2020	2.0	-13.0	-12.0
CLEC2030	4.3	-13.2	-12.9
CLECC2020	-0.3	-12.2	-11.4
CLECC2030	2.2	-8.6	-9.3
BCADD	-23.3	-41.4	-34.8
MTFR	-20.7	-30.5	-29.5





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Yearly BC emissions from GAINS





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Black carbon changes compared to the base run (2005): Arctic Circle

Simulation	Δ burden [%]	Δ surf. air [%]	Δ flux snow&ice [%]
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No-Fin	-0.3	-2.7	-1.9
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CLECC2030 - Base year (2005)





Black carbon column burden change [%]





Black carbon column burden change [%]

-25 -20 -15 -10 -5 0 5 10 15 20 25 Black carbon column burden change [%]

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CLECC2030 - Base year (2005)







spring







autumn





Emission difference



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Conclusions



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- MACEB project has provided interesting tools to study the Arctic climate
 - models
 - measurements
- ECHAM5-HAM2 has deficiencies in transport of tracers to Arctic region (near surface)
 - wet/dry deposition, emissions, clouds, resolution
 - brown carbon?
- domestic sector (fireplaces) emission limitations over Europe will have positive effects to Arctic climate
- transport of BC to Arctic from North America



Thank you for your attention!



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http://www.maceb.fi

Contact: Joni-Pekka.Pietikainen@fmi.fi